DRILL BIT PACKAGES AND METHODS

This application claims priority from U.S. provisional application 60/218,304, filed Jul. 14, 2000, which is hereby incorporated by reference.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to packaging, and particularly to packaging of roller cone drill bits for shipment and/or storage.

BACKGROUND

Roller-Cone and Fixed-Cutter Bits

In contemporary drilling practice, there are two basic categories of rock drill bits: roller-cone bits and fixed cutter bits. Within each of these classifications, a range of sizes and design configurations are available.

A general schematic of a conventional rotary cone bit is shown in FIG. **6**. The most common roller cone bits **60** have three independently rotating "cones" **62** (which may or be not be precisely conical) fitted on three bearings. The cones will have cutting elements **64** or "teeth" attached to, or integral with the cones. The bearings are mounted on "arms" **65** whose other ends are attached to the body of the bit. There is a threaded drill string connection **67**, commonly referred to as the "pin" on the junction of the arms at the upper end of the bit. Generally at least three jet nozzles **68** are present on the bit to direct the flow of drilling "mud" toward the hole bottom. These jets come in a variety of sizes, which may be changed on the site if deemed necessary.

A general schematic of a conventional fixed cutter bit **70** is shown in FIG. **7**. The most common fixed cutter bits have at one end a supporting structure referred to as the "bit head" **72**. Wear-resistant cutting elements **73** are strategically located on the outer and lower surfaces of the bit head, as well as a number of jet nozzles **74**. A further example of this type of rock drill bit is disclosed in U.S. Pat. No. 5,033,559 by Fischer.

A drilling site will generally have a number of bits available, both to deal with normal wear and tear of the bits, and to accommodate various conditions in the hole. A new bit will receive a final inspection to be sure that no part of it is damaged and to exchange nozzles if necessary.

BACKGROUND

Bit Packaging

While a great deal of work has been put into developing the technology of the drill bits themselves, less work has gone into the technology of shipping and storing them. The bits used for drilling oil and gas wells are consumable items which must be shipped to locations in the remotest parts of the world. Bit packaging must provide reasonable protection of bits against rough handling and corrosion during transport and storage. Bit packaging may also be subjected to rough-and-ready handling practices on the rig floor or elsewhere in the field.

There is also some difference between the shipping and storage requirements of roller-cone and fixed-cutter bits, in that roller-cone bits tend to have more of their mass concentrated away from the pin end of the bit, due to the large fraction of the bit's mass in the cones. Thus a roller cone bit is not very stable when balanced on its pin end, but is typically quite stable when allowed to rest with its pin upright.

Roller cone bits have normally been shipped in this stable pin-up position. Small drill bits (e.g. 50–200 pounds in weight) have usually been shipped in a simple box of heavyweight corrugated cardboard, as shown in FIG. **5**. Since the bit containers are likely to encounter rough handling in the field, the cardboard must be very heavy-duty, and these boxes are surprisingly expensive (typically more than $50 each in wholesale quantities). Even so, these boxes are not very durable.

Fixed-cutter bits have been transported with a packaging approach as shown in FIG. **4**. This is a much more elaborate design and is executed in a tough plastic. This design requires that the fixed bit has slots **44** which are designed for make-up and break-out. A U-shaped packaging piece **46** slides into the breakout slots providing a secure seating for the bit. The assembled U-shaped piece and bit are then lowered into the main portion of the package, utilizing posts **45** in the body and corresponding holes **47** in the U-shaped piece to provide an exact seating in the package. Unlike the cardboard boxes, the weight of the bit would not necessarily rest on the bottom of the container, but the weight would be transmitted by the post into the sides of the container.

One constraint on packaging is that the overall length of different bit designs may be different, even for a given hole size. A variety of bit designs are used to adapt to the various kinds of rock which must be penetrated; for example, the average hardness, peak hardness, abrasiveness, or shale content of the formation being drilled will all affect the choice of bit. The size and angulation of the cones and the type and length of teeth chosen will affect the length of the bit which must fit into a package. On the other hand, the need to have packages of varying lengths as well as breadth increases the manufacturing costs of bits.

To summarize, it is desirable that a package be sturdy and provide a stable environment for transporting the bit, as well as being as easy to handle as possible. Protection from the environment is desirable, as are safety concerns which arise from the handling of these awkward, often heavy pieces of equipment. At the same time, the economics of producing the packaging must be considered.

Rotational Molding

Rotational molding is an inexpensive way to form large, molded plastic items. A hollow mold is created, then filled with a measured amount of a plastic powder. The mold is heated, to cause the powder to fuse together on the mold, and rotated, to cause the plastic powder to provide an even coverage. Once the desired surface is coated, the mold is cooled and the article removed.

Innovative Packaging and Methods for Drill Bits

The present application describes a new approach to packaging, transport and/or storage of drill bits. This new approach includes a number of innovations which can be used separately, in combination, or in various subcombinations.

In at least some embodiments, a two-piece, cylindrical polymer container, formed by rotational molding, holds a roller cone in a cones-down position. A cushion of foam in the bottom of the container provides cushioning and lateral stability to the bit, while the lid provides a holder to stabilize the pin. The lid and body, which are slip fit to each other, are preferably held together by strapping, which is preferably constrained within channels formed in the package.

In at least some embodiments, the package has a bottom end which is shaped to avoid rolling during transport (e.g.